Among papers in Section B (Geology, Zoology, Botany, and Anthropology) we notice the following as likely to prove of importance:—*The Structure of Eruptive Mountains*, by Prof. Powell; *On Sex in Flowers*, by Mr. Thos. Meehan; *On the Original Connection of the Eastern and Western Coalfields of the Ohio Valley, On the Continuation of the Fields of the Alleghany Chain to the North of the Delaware River*, and *On the Geographical and Geological Distribution of the Genus Beatricea, and of certain other Fossil Corals in the Rocks of the Cincinnati Group*, all by Prof. Shaler; *On the Classification of the Extinct Fishes of the Lower Types*, and *On the Origin of Structural Variation*, by Prof. Cope; *Notes on the Geology of the Rocky Mountains*, by Prof. Sterry Hunt; *Some Popular Errors concerning the North American Indians*, by Capt. Powell. In a paper by the same author, *On Overplacement*, he asserted that the effects of glacial action had been greatly over-estimated in the western country, and that the "overplacement" in the Mississippi Valley was due rather to the erosion of the atmosphere, the rains of centuries, and the rivers. A curious paper in this section was by a lady, Mrs. H. K. Ingram, *On Atmospheric Concussion as a Means of Disinfection*, in which she confidently advanced the idea, based on the germ-theory of disease, that by means of concussion produced by gunpowder explosion or other effective method, cholera and other epidemic diseases could be effectually prevented or dissipated. In a paper by Lieut.-Col. Mallery, the author held that the Indians are not passing away; there are now in existence, he stated, 300,000 Indians, of whom 50,000 are Sioux. Instead of decreasing with advancing civilisation, they are steadily increasing, and Col. Mallery believes that the native population of America, north of Mexico, at the time of its discovery, has been widely over-estimated. Capt. Powell agreed with Col. Mallery, and stated his conviction that at the time of the discovery of America there were not more than 500,000 natives north of Mexico, while now in the States, Canada, and Alaska there are about 400,000. As president of the Sub-section of Anthropology, Prof. Daniel Wilson gave an interesting address on *Races in America*, presenting a *résumé* of the various theories that had been advanced with respect to American ethnology and the peopling of America, and giving some wise advice as to how future researches ought to be conducted. Another anthropological paper was on the *Origin of the Japanese*, by a native of Tokio, Shuje Isawa, in which the author came to the conclusion that the present Japanese are descended from Hindoo conquerors.

No paper of general importance seems to have been read in permanent Sub-section C (Chemistry), all of them, judging from the titles, being on points mainly of manufacturing interest.

It was decided that the next meeting should be held at St. Louis, and at the closing meeting an Education Committee was appointed with a view to the introduction of science into the schools of the country. Another committee was appointed to report annually on the relations of science to the industrial arts, and the following important resolution was passed in reference to the Signal Service Weather Reports:—

"Resolved, that this Association most respectfully asks the attention of Congress and the country to the great advances in the science of meteorology and in the art of weather prediction, which might be hoped for if the meteorological observations now taken by the Army Signal Office, under the direction of the Secretary of War, were made the subject of special research and discussion by scientific experts.

"Resolved, further, that a committee of five members or fellows be appointed by the President to represent this Association before Congress as petitioners for such permanent and liberal organisation of the meteorological service, that the valuable material collected by it may be utilised in the manner here suggested."

INTRODUCTION AND SUCCESSION OF VERTEBRATE LIFE IN AMERICA[1]

II.

THE reptiles most characteristic of our American cretaceous strata are the *Mosasauria*, a group with very few representatives in other parts of the world. In our cretaceous seas they ruled supreme, as their numbers, size, and carnivorous habits enabled them to easily vanquish all rivals. Some were at least sixty feet in length, and the smallest ten or twelve. In the inland cretaceous sea, from which the Rocky Mountains were beginning to emerge, these ancient "sea serpents" abounded; and many were entombed in its muddy bottom. On one occasion, as I rode through a valley washed out of this old ocean bed, I saw no less than seven different skeletons of these monsters in sight at once. The mosasaurs were essentially swimming lizards, with four well-developed paddles, and they had little affinity with modern serpents, to which they have been compared.

The *Crocodilia* are abundant in rocks of cretaceous age in America, and two distinct types are represented. The tertiary marine beds of the Atlantic coast contain comparatively few crocodilian remains, and all are of modern types, the genus *Gavialis* having one eocene species, and the alligator being represented only in the latest deposits.

It is worthy of special mention in this connection that no true *Lacertilia*, or lizards, and no *Ophidia*, or serpents, have yet been detected in American cretaceous beds; although their remains, if present, would hardly have escaped observation in the regions explored. The former will doubtless be found, as several species occur in the mesozoic of Europe, and perhaps the latter, although the ophidians are apparently a more modern type. In the eocene lake-basins of Western America, remains of lizards are very numerous, and indicate species much larger than any existing to-day.

The first American serpents, so far as now known, appear in the eocene, which contains also the oldest European species.

The *Pterosauria*, or flying lizards, are among the most interesting reptiles of mesozoic time, and many of them left their remains in the soft sediments of our inland cretaceous sea. These were veritable dragons, having a spread of wings of from ten to twenty-five feet.

The strange reptiles known as *Dinosauria*, which, as we have seen, were numerous during the deposition of our triassic shales and sandstones, have not yet been found in American Jurassic, but were well represented here throughout the cretaceous, and at its close became extinct. These animals possess a peculiar interest to the anatomist, since, although reptilian in all their main characters, they show clear affinities with the birds, and have some features which may point to mammals. The cretaceous dinosaurs were all of large size, and most of them walked on the hind feet alone, like modern struthious birds. Near the base of our cretaceous formation in beds which I regard as the equivalent of the European Wealden, the most gigantic forms of this order yet discovered have recently been brought to light. One of these monsters (*Titanosaurus montanus*) from Colorado, is by far the largest land animal yet discovered, its dimensions being greater than was supposed possible in an animal that lived and moved upon the land. It was some fifty or sixty feet in length, and, when erect, at least thirty feet in height. It doubtless fed upon the foliage of the mountain forests, portions of which are preserved with its remains. With *Titanosaurus* the bones of smaller dinosaurs, one (*Nanosaurus*) not larger than a cat, as well as those of crocodiles and turtles, are not uncommon. The recent discovery of these interesting remains, many and various, in strata that had long been pronounced by professional explorers barren of vertebrate fossils, should teach caution to those who decline to accept the imperfection of our knowledge to-day as a fair plea for the supposed absence of intermediate forms.

In the marine cretaceous beds of the west only a single dinosaur (*Hadrosaurus agilis*) has been found, but in the higher fresh-water beds which mark the close of this formation their remains are numerous, and indicate several well-marked species, if not genera.

The first appearance of birds in America, according to our present knowledge, was during the cretaceous period, although many announcements have been made of their existence in preceding epochs. The evidence of their presence in the trias, based on footprints and other impressions is at present, as we have seen, without value, although we may confidently await their discovery there if not in older formations. *Archæopteryx*, from the European Jura, the oldest bird known, and now fortunately represented by more than a single specimen, clearly indicates a much higher antiquity for the class. The earliest American forms at present known are the *Odontornithes*, or birds with teeth, which have been exhumed within the last few years

[1] Abstract of a lecture delivered at the Nashville meeting of the American Association, August 30, by Prof. O. C. Marsh. Continued from p. 450.

from the chalk of Kansas. The two genera *Hesperornis* and *Ichthyornis* are types of distinct orders, and differ from each other and from *Archæopteryx* much more than do any existing birds among themselves, thus showing that birds are now a closed type, and that the key to the history of the class must be sought for in the distant past.

In *Hesperornis* we have a large aquatic bird, nearly six feet in length, with a strange combination of characters. The jaws are provided with teeth, set in grooves; the wings were rudimentary, and useless, while the legs were very similar to those of modern diving birds. This last feature was merely an adaptation, as the more important characters are struthious, showing that *Hesperornis* was essentially a carnivorous swimming ostrich. *Ichthyornis*, a small flying bird, was stranger still, as the teeth were in sockets, and the vertebræ biconcave, as in fishes and a few reptiles. *Apatornis* and all other allied forms occur in the same beds, and probably all were provided with teeth. It is strange that the companions of these ancient toothed birds should have been pterodactyls without teeth. In the later cretaceous beds of the Atlantic coast various remains of aquatic birds have been found, but all are apparently distinct from those of the west.

During the tertiary period birds were numerous in this country, and all yet discovered appear to have belonged to modern types.

It is now generally admitted by biologists who have made a study of the vertebrates, that birds have come down to us through the dinosaurs, and the close affinity of the latter with recent struthious birds will hardly be questioned. The case amounts almost to a demonstration, if we compare, with dinosaurs, their contemporaries, the mesozoic birds. The classes of birds and reptiles, as now living, are separated by a gulf so profound, that a few years since it was cited by the opponents of evolution as the most important break in the animal series, and one which that doctrine could not bridge over. Since then, as Huxley has clearly shown, this gap has been virtually filled by the discovery of bird-like reptiles and reptilian birds. *Compsognathus* and *Archæopteryx* of the old world, and *Ichthyornis* and *Hesperornis* of the new, are the stepping-stones by which the evolutionist of to-day leads the doubting brother across the shallow remnant of th gulf once thought impassable.

It remains now to consider the highest group of the animal kingdom, the class *Mammalia*, which includes Man. Of the existence of this class before the trias we have no evidence, either in this country or in the old world, and it is a significant fact that at essentially the same horizon in each hemisphere, similar low forms of mammals make their appearance. Although only a few incomplete specimens have been discovered, they are characteristic and well preserved, and all are apparently marsupials, the lowest mammalian group which we know in this country, living or fossil. The American triassic mammals are known at present only from two small lower jaws, on which is based the genus *Dromotherium*, supposed to be related to the insect-eating *Myrmecobius*, now living in Australia.

Although the Jura of Europe has yielded other similar mammals, we have as yet none of this class from that formation; while, from rocks of cretaceous age, no mammals are known in any part of the world.

In the lowest tertiary beds of this country a rich mammalian fauna suddenly makes its appearance, and from that time through the age of mammals to the present, America has been constantly occupied by this type of life in the greatest diversity of form. Fortunately, a nearly continuous record of this life, as preserved, is now accessible to us, and ensures great additions to our knowledge of the genealogy of mammals, and perhaps the solution of more profound problems.

The boundary line between the cretaceous and tertiary in the region of the Rocky Mountains has been much in dispute during the last few years, mainly in consequence of the uncertain geological bearings of the fossil plants found near this horizon. The accompanying invertebrate fossils have thrown little light on the question, which is essentially whether the great lignite series of the West is uppermost cretaceous, or lowest eocene. The evidence of the numerous vertebrate remains is, in my judgment, decisive, and in favour of the former view.

This brings up an important point in palæontology, one to which my attention was drawn several years since, namely, the comparative value of different groups of fossils in marking geological time. In examining the subject with some care, I found that for this purpose plants, as their nature indicates, are most unsatisfactory witnesses; that invertebrate animals are much better; and that vertebrates afford the most reliable evidence of climatic and other geological changes. The sub-divisions of the latter group, moreover, and in fact all forms of animal life, are of value in this respect, mainly according to the perfection of their organisation, or zoological rank. Fishes, for example, are but slightly affected by changes that would destroy reptiles or birds, and the higher mammals succumb under influences that the lower forms pass through in safety. The more special applications of this general law, and its value in geology, will readily suggest themselves.

The evidence offered by fossil remains is, in the light of this law, conclusive, that the line, if line there be, separating our cretaceous from the tertiary, must at present be drawn where the dinosaurs and other mesozoic vertebrates disappear, and are replaced by the mammals, henceforth the dominant type.

It is frequently asserted, and very generally believed, that the large number of huge *Edentata* which lived in North America during the post-pliocene, were the results of an extensive migration from South America soon after the elevation of the Isthmus of Panama, near the close of the tertiary. No conclusive proof of such migration has been offered, and the evidence it seems to me, so far as we now have it, is directly opposed to this view. No undoubted tertiary edentates have yet been discovered in South America, while we have at least two species in our miocene, and during the deposition of our lower pliocene large individuals of this group were not uncommon as far north as the forty-third parallel of latitude, on both sides of the Rocky Mountains. In view of these facts and others which I shall lay before you, it seems more natural to conclude from our present knowledge that the migration which no doubt took place was from north to south. The edentates finding thus in South America a congenial home flourished greatly for a time, and, although the larger forms are now all extinct, diminutive representatives of the group still inhabit the same region.

The ungulates are the most abundant mammals in the tertiary, and the most important, since they include a great variety of types, some of which we can trace through their various changes down to the modified forms that represent them to-day. Of the various divisions in this comprehensive group, the perissodactyle, or odd-toed ungulates, are evidently the oldest, and throughout the eocene are the prevailing forms. Although all of the perissodactyles of the earlier tertiary are more or less generalised, they are still quite distinct from the artiodactyles, even at the base of the eocene. One family, however, the *Coryphodontidæ*, which is well represented at this horizon, both in America and Europe, although essentially *Perissodactyle*, possesses some characters which point to a primitive ungulate type from which the present orders have been evolved. Among these characters are the diminutive brain, which in size and form approaches that of the reptiles, and also the five-toed feet from which all the various forms of the mammalian foot have been derived. Of this family, only a single genus, *Coryphodon* (*Bathmodon*), is known, but there were several distinct species. They were the largest mammals of the lower eocene, some exceeding in size the existing tapirs.

In the middle eocene, west of the Rocky Mountains, a remarkable group of ungulates makes its appearance. These animals nearly equalled the elephant in size, but had shorter limbs. The skull was armed with two or three pairs of horn-cores, and with enormous canine tusks. The brain was proportionally smaller than in any other land mammal. The feet had five toes, and resembled in their general structure those of *Coryphodon*, thus indicating some affinity with that genus. These mammals resemble in some respects the perissodactyles, and in others the proboscidians, yet differ so widely from any known ungulates, recent or fossil, that they must be regarded as forming a distinct order, the *Dinocerata*.

Besides these peculiar mammals which are extinct, and mainly of interest to the biologist, there were others in the early tertiary which remind us of those at present living around us. When a student in Germany some twelve years ago, I heard a world-renowned professor of zoology gravely inform his pupils that the horse was a gift of the old world to the new, and was entirely unknown in America until introduced by the Spaniards. After the lecture I asked him whether no earlier remains of horses had been found on this continent, and was told in reply that the reports to that effect were too unsatisfactory to be presented as facts in science. This remark led me, on my return, to examine the subject myself, and I have since unearthed, with my own hands, not less than thirty distinct species of the horse tribe, in the tertiary deposits of the west alone; and it is now, I think, generally admitted that America is, after all, the true home of the horse.

I can offer you no better illustration than this of the advance vertebrate palæontology has made during the last decade, or of the important contributions to this progress which our Rocky Mountain region has supplied.

The oldest representative of the horse at present known is the diminutive *Eohippus* from the lower eocene. Several species have been found, all about the size of a fox. Like most of the early mammals, these ungulates had fourty-four teeth, the molars with short crowns, and quite distinct in form from the premolars. The ulna and the fibula were entire and distinct, and there were four well-developed toes and a rudiment of another on the fore-feet, and three toes behind. In the structure of the feet and in the teeth, the *Eohippus* indicates unmistakably that the direct ancestral line to the modern horse has already separated from the other perissodactyles. In the next higher division of the eocene another genus (*Orohippus*) makes its appearance, replacing *Eohippus*, and showing a greater, although still distant, resemblance to the equine type. The rudimentary first digit of the fore-foot has disappeared, and the last premolar has gone over to the molar series. *Orohippus* was but little larger than *Eohippus*, and in most other respects very similar. Several species have been found in the same horizon with *Dinoceras*, and others lived during the upper eocene with *Diplacodon*, but none later.

Near the base of the miocene, in the brontotherium beds, we find a third closely-allied genus, *Mesohippus*, which is about as large as a sheep, and one stage nearer the horse. There are only three toes and a rudimentary splint bone on the fore-feet, and three toes behind. Two of the premolar teeth are quite like the molars. The ulna is no longer distinct, or the fibula entire, and other characters show clearly that the transition is advancing. In the upper miocene *Mesohippus* is not found, but in its place a fourth form, *Miohippus*, continues the line. This genus is near the *Anchitherium* of Europe, but presents several important differences. The three toes in each foot are more nearly of a size, and a rudiment of the fifth metacarpal bone is retained. All the known species of this genus are larger than those of *Mesohippus*, and none pass above the miocene.

The genus, *Protohippus* of the lower pliocene, is yet more equine, and some of its species equalled the ass in size. There are still three toes on each foot, but only the middle one, corresponding to the single toe of the horse, comes to the ground. This genus resembles most nearly the *Hipparion* of Europe. In the pliocene we have the last stage of the series before reaching the horse, in the genus *Pliohippus*, which has lost the small hoofiets, and in other respects is very equine. Only in the upper pliocene does the true *Equus* appear and complete the genealogy of the horse, which in the post-tertiary roamed over the whole of North and South America and soon after became extinct. This occurred long before the discovery of the Continent by Europeans, and no satisfactory reason for the extinction has yet been given. Besides the characters I have mentioned there are many others in the skeleton, skull, teeth, and brain of the forty or more intermediate species, which show that the transition from the eocene *Eohippus* to the modern *Equus* has taken place in the order indicated, and I believe the specimens now at New-Haven will demonstrate the fact to any anatomist. They certainly carried prompt conviction to the first of anatomists who was the honoured guest of the Association a year ago, whose genius had already indicated the later genealogy of the horse in Europe, and whose own researches so well qualified him to appreciate the evidence here laid before him. Did time permit I might give you at least a probable explanation of this marvellous change, but justice to the comrades of the horse in his long struggle for existence demands that some notice of their efforts should be placed on record.

(*To be continued.*)

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 17.—M. Peligot in the chair.—The president requested the meeting to designate one of their fellows to represent the Academy in the annual public meeting of the five academies, which will take place on October 25.—M. Tresca then, in the name of M. Leverrier, presented to the Academy vol. viii. of the "Atlas Météorologique de l'Observatoire de Paris pour l'an 1876."—A note by M. Faye, on the atlas of the superior movements of the atmosphere, by M. H. Hildebrandsson. The author bases his work on the observation of cirrhus clouds.—A note by M. G. de Saporta on the discovery of fossil plants in the tertiary strata in the vicinity of the North Pole.—On an erratic block of granite situated in the neighbourhood of Geneva, by M. de Marignac. It appears that the block in question is a mass of about 300 cubic metres of granite, and that the prefect of the Department, Haute Savoie, has given permission to a Railway Company to take possession of it and to cut it to pieces. M. de Marignac, who is the owner of the ground upon which it lies, now recommends the preservation of the block and offers it to the Academy together with the area it lies upon, under the sole condition that it shall be preserved. M. Dumas spoke in favour of M. de Marignac's proposition.—On the spontaneous disappearance of phylloxera, by H. Marès. —M. P. de Tchihatcheff then presented to the Academy his translation of M. Grisebach's work, "The Vegetation of the Globe," and made some remarks on the same.—M. Alluard read a memoir on a new condensation-hygrometer, invented by himself.—A letter from M. E. Stephan announcing the discovery of a new comet by M. Coggia was read. (Of this we gave the details in the Astronomical Column of our last number, p. 442.) The letter further contained details of an observation of one of the satellites of Mars, by M. Borrelly, made at Marseilles.—M. Leverrier transmitted to the Academy details of MM. Paul and Prosper Henry's observation of the same satellite, made with the equatorial in the garden of the Paris Observatory.—M. P. H. Boutigny pointed out that in a passage in his work, "Études sur les corps à l'état sphéroïdal," published some thirty years ago, he expressed his belief in the existence of satellites of Mars and pronounced the hope of their future discovery.—New researches on the ammoniacal fermentation of urine and spontaneous generation, by MM. P. Cazeneuve and Ch. Livon.—On the physiological action of salicylate of soda, by MM. Bochefontaine and Chabbert.—A note by M. V. Duram on a luminous meteor observed on September 11 at Boën (Loire), and on a shock of earthquake felt at the same place on September 12. The meteor was of unusual brilliancy; it appeared in the east of the sky at 7.45 P.M.; its elevation above the horizon was but small; it left a long curved trail, and its appearance was marked by a slight detonation; the direction of its path was from north to south. The shock of earthquake was felt at 6h. 52m. true time, and lasted several seconds.—M. Faye then drew the attention of the Academy to a memoir just published by M. P. de Saint Robert, on the spherical movement of the pendulum, with regard to the resistance of the air and the rotation of the earth.

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